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ROYAL AIRCRAFT ESTABLISHMENT

FARNBOROUGH, HANTS

TECHNICAL NOTE No: G.W.238

# A Mk.II CONTROL SYSTEM FOR THE SYNCHRONOUS OPERATION OF ASKANIA KINETHEODOLITES AND ASSOCIATED FLASH UNITS

## AS USED ON GUIDED WEAPONS RANGES

by

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ROYAL AIRCRAFT ESTABLISHMENT, FARNBOROUGH

# A Mk.II Control System for the synchronous operation of Askania kinetheodolites and associated flash units as used on guided weapons ranges

by

R. J. Garvey, B.Sc. (Eng.)

R.A.E. Ref: BGW/41/2

SUMMARY

The kinetheodolites are used to determine the trajectory and velocity of guided weapons; five or more kinetheodolites being dispersed on the range and controlled from a common point within the launching area.

A Controller operates the kinetheodolite shutters and triggers flash lamps which expose bearing and elevation readings on the kinetheodolite films. The lamps are flashed synchronously to within ±200 microseconds the interval between flashes being 200 milliseconds ±200 microseconds. The shutter operation is synchronised to the lamps to within ±1 millisecond. It is estimated that for the Larkhill Guided Weapons range these limits correspond to errors of ±1 ft in determining the trajectory and ±0.1% of velocity.

The report describes a Mk.II version of the equipment which employs electronic delay circuits in place of the relays used in the Mk.I equipment and which is more suitable for operating the remote kinetheodolites over long telephone lines.

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## 1 Introduction

Kinetheodolites are used on guided weapons ranges to determine the trajectory and axial velocity of special weapons. A number of kinetheodolites are dispersed on the range and controlled over land lines from a common control station within the launching area.

The kinetheodolite as illustrated by Fig.1 consists essentially of:

(a) an optical axis which can be trained in bearing and elevation by an operator tracking the moving projectile.

(b) a camera shutter and film traversing mechanism normally operated at the rate of five frames per second.

A record of the bearing and elevation of the optical axis is exposed on each frame by flashing small gas discharge lamps fitted near the bearing and elevation scales; the images being projected on to the film by a simple optical system. The camera shutter exposes an image of the projectile with respect to the optical axis on each frame so that corrections can be made for tracking errors when the film is analysed. A typical frame exposure is shown by Fig.2.

The bearing and elevation readings from two kinetheodolites, placed at the extremities of a known base line, give the position of the projectile in space and since successive readings are obtained at known time intervals both the trajectory and velocity of the projectile can be determined. To cover the whole of the trajectory it is normal to employ five or more kinetheodolites suitably dispersed over the range and synchronously operated.

The first requirement of a control system is that the bearing and elevation scale exposures of all kinetheodolites be made synchronously and for the interval between successive exposures (normally 200 milliseconds) to be accurately repeated. Any asynchronism between the flash lamps of each kinetheodolite will result in an error in determining the trajectory and hence the velocity, while an error in the repetition rate will have a direct effect on the velocity evaluation. A second requirement is that the exposure showing the position of the projectile with reference to the optical axis of the theodolite be made at the same instant as the scale exposures. This involves synchronising the electro-mechanical operation of the camera shutter with the triggering of the gas discharge lamps. Any asynchronisation between the shutter and lamps will result in false corrections being made when the films are analysed.

The accuracy to which the trajectory and velocity must be determined require that:

(a) the asynchronisation between the operation of all flash lamps be not greater than ±200 microseconds.

(b) the interval between the successive operation of the flash lamps be within ±200 microseconds of the nominal value which is normally 200 milliseconds.

(c) the shutter operation be synchronised to within ±1 millisecond of that of the flash lamps.

The kinetheodolites were originally operated by a Controller designed by the Askania works but this did not meet the requirements outline above. An improved system was, therefore, designed for use at the guided weapons range, Larkhill and a Mk.I equipment[1] has been in

service since August 1949. The Mk.II version employs electronic circuits in place of the variable delay relays of the Mk.I equipment, is designed for operation over longer land lines and gives better accuracy.

This report describes the Mk.II development and includes a brief description of the kinetheodolite and flash lamp unit.

The control equipment was manufactured by Cinema Television Ltd. who engineered the system from the prototype equipment designed by the Royal Aircraft Establishment. The recorder was made by S.G. Brown Ltd. A description of the engineered equipment together with wiring diagrams is given in a service manual issued by Cinema Television Ltd[5].

## 2 Electrical Operation of the Kinetheodolites

As a full description of the kinetheodolite (Fig.1) is given in a translation of the German Handbook[2], only a brief description of the electrical operation is given here.

The shutter (Fig.3) is of the "Venetian Blind" type, the vanes being rotated through 180° for each exposure by a gear sector which engages small pinions on each vane. The gear sector when released by the armature of the electromagnet moves to the right or left under the action of a tension spring. The end of this spring is attached to a wheel which is motor driven through 180° after each exposure thus cocking the mechanism for the following exposure.

The rotary contact shown on Fig.3 is closed when the shutter vanes are in the fully open position; this provides a monitoring signal for synchronising the shutter operation with that of the scale flash lamps.

The connections of the motor which cocks the shutter mechanism are shown on the circuit diagram of Fig.4. The motor runs continuously and the intermittent drive obtained by an electromagnetic clutch. This clutch is energised via a commutator geared to the cocking wheel. When the gear sector has travelled to either extremity following an exposure a side contact is closed which energises the clutch so that the cocking wheel is rotated through 180°, the supply to the clutch being then interrupted. At the same time the clutch couples the motor to the film traverse mechanism so that a frame is automatically wound over after each exposure. The electrical operation of the kinetheodolite is thus fully automatic consequent upon triggering the shutter release magnet.

An additional commutator interrupts the circuit of the shutter release magnet; this prevents possible repeated operation of the shutter while the film is being traversed.

The time taken for the shutter vanes to operate depends on the ambient temperature, local battery voltage and the mechanical adjustment of the particular mechanism; it is normally about 30 milliseconds. The effects of temperature and voltage on a particular mechanism are shown by the test results given below; the time quoted is that for the shutter vanes to reach the fully open position after switching volts to the release magnet.

| Temperature °C | Operating Voltage volts | Operating Time milliseconds |
|---|---|---|
| -20 | | 42.5 |
| -10 | | 40 |
| 0 | 12 | 38 |
| 20 | | 36 |
| 40 | | 34 |
| | 8 | 37 |
| 25 | 12 | 35 |
| | 16 | 33 |
| | 20 | 31 |

The exposure time for each operation of the shutter vanes is normally about 10 milliseconds.

## 3 Description of the H.T. Flash Unit

The Flash Unit[3] operates two gas discharge lamps fitted near the bearing and elevation scales of the kinetheodolite. These give a high intensity flash of short duration so that a record of bearing and elevation is exposed on each frame of the kinetheodolite film. The short duration flash of about 100 microseconds is necessary to avoid blurred exposures of the scale readings at the high tracking rates employed.

The circuit diagram of the Flash Unit is illustrated by Fig.5. It consists of a power pack which supplies the necessary high voltage and a thyratron which acts as a switch in series with the flash lamps. Each input pulse fires the thyratron so that a 1MFD condenser is discharged through the lamps and the thyratron self extinguished. The thermal delay switch shown protects the thyratron, when the unit is first switched on, by allowing the cathode to attain its working temperature before the h.t. is switched to the anode.

## 4 Description of Controller (See Fig.13)

### 4.1 General Description

A 5 p.p.s. signal is supplied to the Controller from a Central Timing Unit[4] see Fig.6. This unit consists of a 10 Kc/s quartz oscillator and electronic dividing circuits supplying timing and reference signals to the various measuring stations and observation posts on the range; it is used on the range as a separate equipment and is not part of the Kinetheodolite Controller.

Referring to the schematic diagram of Fig.7: the 5 p.p.s. signal from the Central Timing Unit is fed via separate variable delay circuits to each kinetheodolite shutter mechanism and via a common delay circuit to all the remote Flash Units. The variable delay circuits are adjusted so that the output pulse is sufficiently in advance of the common flash pulse for the shutter vanes of each kinetheodolite to be passing through their mid-position as the scale lamps flash. Rotary contacts fitted to the shutters (Fig.3) are closed when the shutter vanes are in the mid-position and synchronisation is effected by adjusting the variable delays until the shutter return pulses provided by these contacts are each in phase with the common flash pulse as seen on a double beam C.R.O.

The return shutter pulses also operate neon indicators and they are recorded together with the flash pulse on a suitable multi-channel recorder. The record obtained gives an overall check on the operation of the system and shows the degree of shutter synchronisation effected and maintained.

In operating the system each kinetheodolite is synchronised as necessary; the 5 p.p.s. signal from the Central Timing Unit is then switched off in preparation for the actual run and the particular kinetheodolite and Flash Units that are to be operated selected by closing appropriate switches on the control panel. The run commences when the 5 p.p.s. signal is gated from the Central Timing Unit at zero time, i.e. when the weapon to be tracked is fired off the launcher. To conserve film each kinetheodolite is switched off locally when tracking has ceased while the Controller is switched off automatically at the end of the run. The recorder is normally switched on and off automatically from the range control room but can be controlled locally if necessary.

## 4.2 Delay Circuit

The delay circuits employed in the Controller consists in each case of a flip-flop as illustrated by Fig.8a. The waveform at the anode of $V_2$ is differentiated and the positive pip removed with a diode. The output pulse is thus derived from the trailing edge of the flip-flop waveform and is displaced from the input pulse by a time delay corresponding to the flip-flop action. The time delay can be varied by altering the value of the resistance connected to the grid of $V_2$ as illustrated by the graph of Fig.8b.

The delay time of the flip-flop circuit is relatively independant of ambient temperature changes or of the steady h.t. voltage and any drift due to valve ageing can be taken up in the preset or variable resistance controls. Apart from slow changes it is necessary that any given time delay be repeated for successive operation to within ±100 microseconds. To meet this requirement it is necessary to trigger the flip-flop with a steep fronted pulse of short duration and to ensure that there is no 50 c.p.s. or transient disturbance superimposed on the exponential voltage rise at the grid of $V_2$. The flip-flop is accordingly triggered via a pulse shaper and supplied with a well smoothed and stabilised h.t.

## 4.3 Control Circuits

The 5 p.p.s. signal from the Central Timing Unit is fed to the pulse shaper circuit detailed by Fig.9. This consists of a triode biassed beyond cut-off to clip any low amplitude noise followed by an amplifier and squaring flip-flop. The output of the latter is differentiated and the negative pips removed by the crystal diode. A crystal is used here to avoid the introduction of 50 c.p.s. ripple that would result from the heater-cathode leakage of a normal valve. The diode connected to the input side of the flip-flop removes any negative component from the triggering signal while the 0.002 mfd condenser short circuits any high frequency pick-up. The shaped pulses are fed to six variable delay circuits and to a common circuit which introduces a fixed delay of about 70 milliseconds.

The variable delay circuit is shown on Fig.10; this introduces a delay of 20 to 60 milliseconds. The output of each variable delay circuit triggers the kinetheodolite shutters, the pulses being fed to each remote station via underground cables to a local amplifier. The output of the fixed delay circuit is fed to cathode followers in each control channel and then via the underground cables and local amplifier to the remote flash units. The flash pulses from each control channel are in phase while the shutter pulses can each be varied to be between 10 to 50 milliseconds in advance of the common flash pulse according to the delay of each shutter mechanism.

The rotary contact on each shutter mechanism transmits return pulses via the underground cable to the receiving circuit detailed by Fig.10. This circuit consists of a triode biassed beyond cut-off to clip any low amplitude noise followed by an amplifier and pulse widening flip-flop. The pulse widener operates a neon which gives a visual indication by blacking out when the kinetheodolite shutter is operating.

## 4.4 Recorder Amplifiers and Monitoring C.R.O.

The return shutter pulses are fed to the recorder amplifiers and monitoring C.R.O. as shown by Fig.11. Each recorder channel has a two stage amplifier with the pen connected in the plate circuit of the second valve. The 100K resistor in parallel with the pen circuit prevents the valve anode

floating when the circuit through the paper is interrupted. The records are obtained by traversing a carbon backed "teledeltos" paper under a transverse row of fixed electrodes or pens so that the amplified input signals burn corresponding time traces on the paper. The shutter return pulses and common flash pulses are recorded against a 100 p.p.s. time trace so that an overall check on the synchronisation and operation of the system is obtained. The 100 p.p.s. signal is switched from the Central Timing Unit via a gate circuit operated at zero time; individual kinetheodolite film exposures can thus be related to an accurate time scale and to data obtained by other range instrumentation.

The double beam C.R.O. shown on Fig.11 is used for synchronising the shutter operation of each kinetheodolite. The flash pulse is presented on one beam and the return shutter pulse on the other. The synchronising control is then adjusted until the two signals are seen to be in phase. A free running time base for the C.R.O. is unsuitable since it is not practical to synchronise the presentation of such low frequencies or to obtain sufficient resolution along the time axis. The time base is accordingly triggered by the 5 p.p.s. output from the pulse shaper (synch. pulse); this pulse being about 70 milliseconds in advance of those being examined. The circuit of the C.R.O. is of conventional design and is detailed in the service manual[5].

## 4.5 Local Amplifier

This unit is installed local to the remote kinetheodolite and it amplifies the shutter and flash pulses received from the Controller. This circuit is shown by Fig.12.

The shutter pulse is fed to a triode biassed beyond cut-off to clip any low amplitude noise followed by an amplifier and pulse widening flip-flop. The flip-flop widens the pulse so that it is of sufficient duration to operate the shutter solenoid. The diode and condenser connected to the input grid of the flip-flop remove any negative component and high frequency pick-up from the operating signal. The output of the pulse widener is fed to a triode having a Siemens high speed relay in the plate circuit; this relay operates the shutter solenoid. Relay B is a post office type 3000 relay having an operating time of about 35 milliseconds; its function is to interrupt the inductive solenoid before A drops out and so protect the contacts of the high speed relay. The random variations in the operating time of a type 3000 relay prohibit it being used to switch the shutter solenoid directly. The balancer is switched in antiphase to the relay valve to equalise the load and thus prevent fluctuations in the h.t. voltage. The push switch shown in the relay circuit is used for manual operation of the shutter mechanism.

The flash pulse is fed via a clipper and amplifier to a cathode follower. The latter feeds the signal at the necessary low impedance to the grid of the thyratron in the h.t. flash unit. The condenser connected to the grid of the cathode follower short circuits any high frequency spikes picked up in the preceding circuits and cable.

The rotary contact fitted to the shutter vanes earths the grid of a cathode follower in the local amplifier so that a pulse is transmitted via the telephone cable back to the controller.

## 4.6 Line Installation

The operating pulses are transmitted from the central control station to the remote kinetheodolite and flash units via telephone cables. The individual lines are terminated in balancing transformers as shown on figures 10 and 12; this eliminates "cross-talk" between the signals and from other transmissions in the same multi-core cable.

A 20 lb cable is installed at the Larkhill range. This has the following characteristics at a 1000 c.p.s:

| | |
|---|---|
| Attenuation | 1 db per ml. |
| Characteristic Impedance | 453 ohms $\sqrt{40^{\circ}}$ |
| Propagating Delay | 10 microseconds per ml. |

The longest cable run is about 4 miles, the propagation delay is therefore negligible as regards the synchronous operation of the kinetheodolite shutters and flash lamps.

### 4.7 The Recorder

The shutter return pulses together with the common flash pulse and a 100 p.p.s. time trace are recorded on a 12 channel recorder, see Fig.14; this gives an overall check on the synchronisation and operation of the system.

The records are obtained by traversing a carbon backed paper under a transverse row of fixed electrodes or pens; the pulses to be recorded being fed to the pens via amplifiers as previously described. The pens and the roller which supports the paper and completes the electrical circuit are silver plus rhodium plated to withstand the arduous electrical and mechanical conditions of operation. The drive mechanism consists of a motor and 2 speed gear box driving a roller, spring loaded on to the paper. The motor runs continuously and is engaged to the gear box by a solenoid operated clutch. The paper spills in to a container and is wound by hand on to the take up spool. Paper speeds of 10 or 25 inches per second can be obtained. A roller arm on the take off spool operates a micro-switch which lights a warning lamp indicating that only 50 ft of paper is left on this spool.

## 5 Accuracy

So far as the control system is concerned the accuracy to which the trajectory and velocity of the projectile can be determined depends upon the regular and synchronous operation of the flash lamps and shutter mechanisms.

The pulses which control the flash lamps and shutters are locked to a crystal oscillator having a frequency stability of a few parts in 100,000 and any irregularity in the nominal 200 millisecond interval between pulses will be introduced by the delay circuits; tests show this to be not greater than ±100 microseconds.

With the line installation at the Larkhill range the delays in transmitting the pulses to the remote kinetheodolites and flash units will be not greater than 40 microseconds and will depend on the site of each equipment.

The accuracy to which the shutter operations can be synchronised depends upon

(a) the degree to which asynchronisation can be observed on the monitoring C.R.O.

(b) the random time variations inherent in the design of the shutter mechanism.

Tests show that the shutters can be synchronised to within ±1 millisecond. The shutter exposure on the film is used to correct the tracking error; shutter assynchronisation has therefore only a second order effect on the results obtained particularly with good tracking.

Summarising the above it can be stated that

(a) asynchronisation between the operation of all flash lamps is not greater than ±200 microseconds.

(b) the interval between successive operations of the flash lamps is within ±200 microseconds of the nominal value.

(c) the shutter operation can be synchronised to within ±1 millisecond to that of the flash lamps.

The effect of these errors in determining the trajectory depends upon the disposition of the kinetheodolites with respect to the trajectory and on the skill of the operators in tracking the projectile. It is estimated that on the Larkhill range the errors quoted correspond to an error of not more than ±1 ft in space; such a discrepancy being comparable with those due to the surveying of the kinetheodolites and with the optical orientation of the kinetheodolite axis. The velocity evaluation will depend upon the accuracy to which the trajectory fixes are made; the errors introduced by irregular operation of the flash lamps however when they are operated at the rate of 5 p.p.s. will be not greater than ±0.1%.

## REFERENCES


| No. | Author | Title, etc. |
|---|---|---|
| 1 | R. J. Garvey | A Controller for the Synchronous Operation of four Askania Kinetheodolites and Associated Flash Units. R.A.E. Technical Note No. G.W.62, February, 1950. |
| 2 | War Office | Handbook for the Kinetheodolite Installation Mks. I and II. May, 1941. |
| 3 | General Electric Co. | Handbook for Kinetheodolite Flash Units. 1950. |
| 4 | R. J. Garvey | Central Timing Equipment, G.W. Range Larkhill. R.A.E. Technical Note No. G.W.67, February, 1951. |
| 5 | Cinema Television Ltd. | Operational Handbook of Kinetheodolite Controller Mk.II. March, 1953. |

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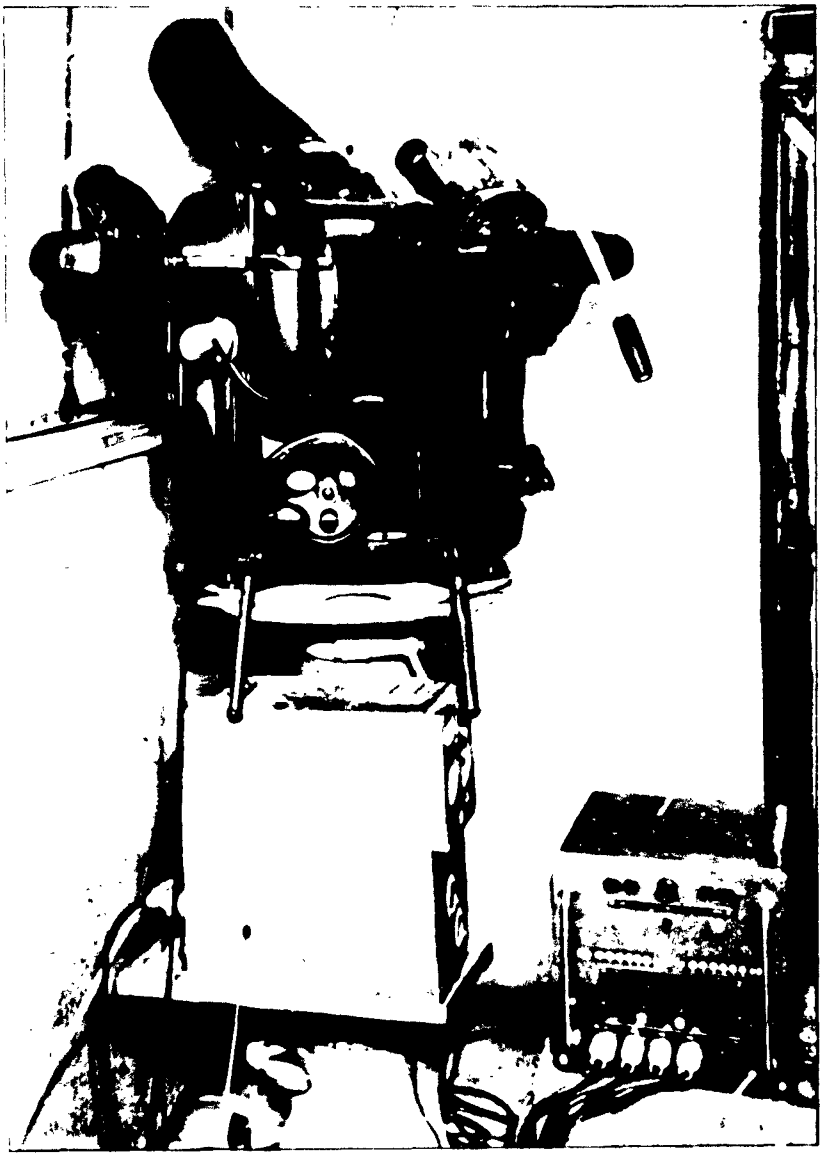
KINE-THEODOLITE



FLASH UNIT LOCAL AMPLIFIER

FIG.1. KINE—THEODOLITE AND ASSOCIATED EQUIPMENT

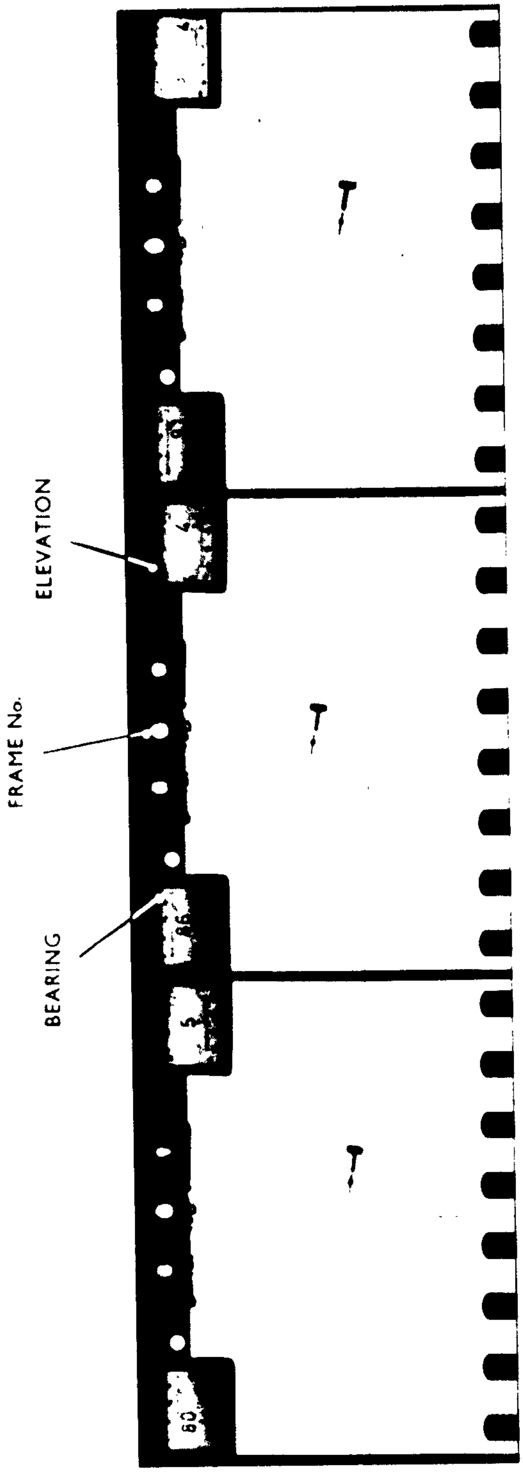



FIG.2. TYPICAL KINE-THEODOLITE FILM RECORD

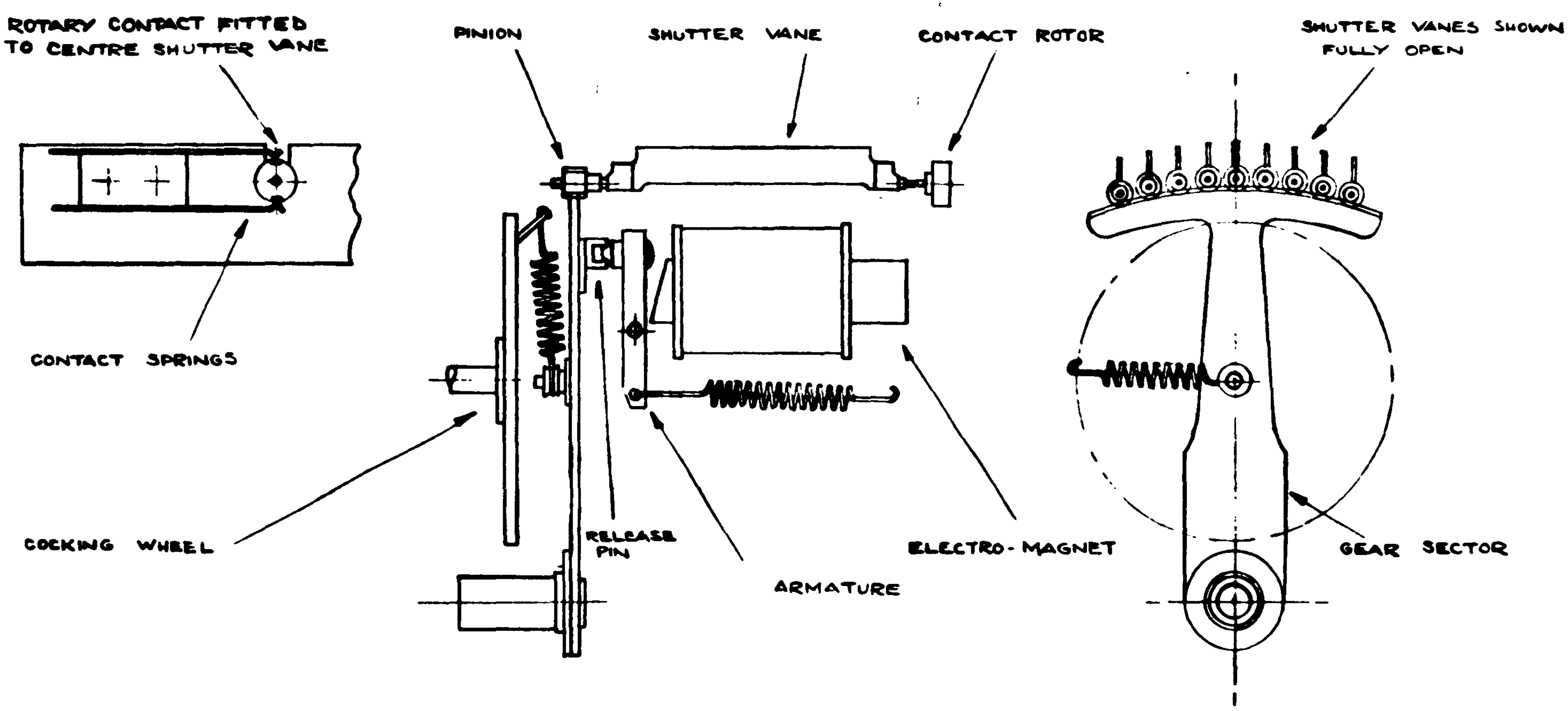



FIG. 3. KINE-THEODOLITE SHUTTER MECHANISM

No. GW/P/4225

T.N. GW 238.

FIG. 4.

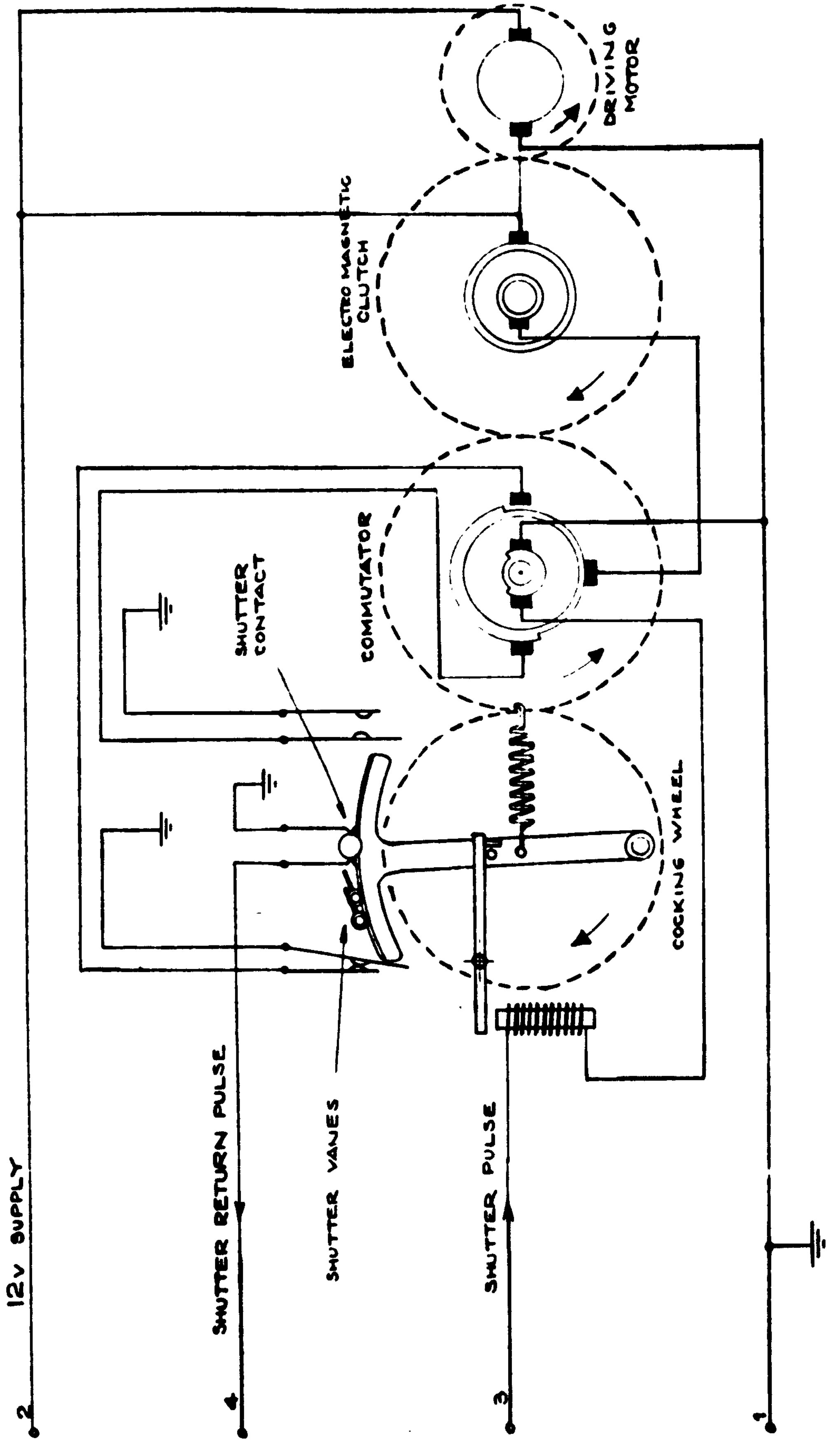



FIG. 4. CIRCUIT DIAGRAM OF KINE-THEODOLITE

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FIG. 5.

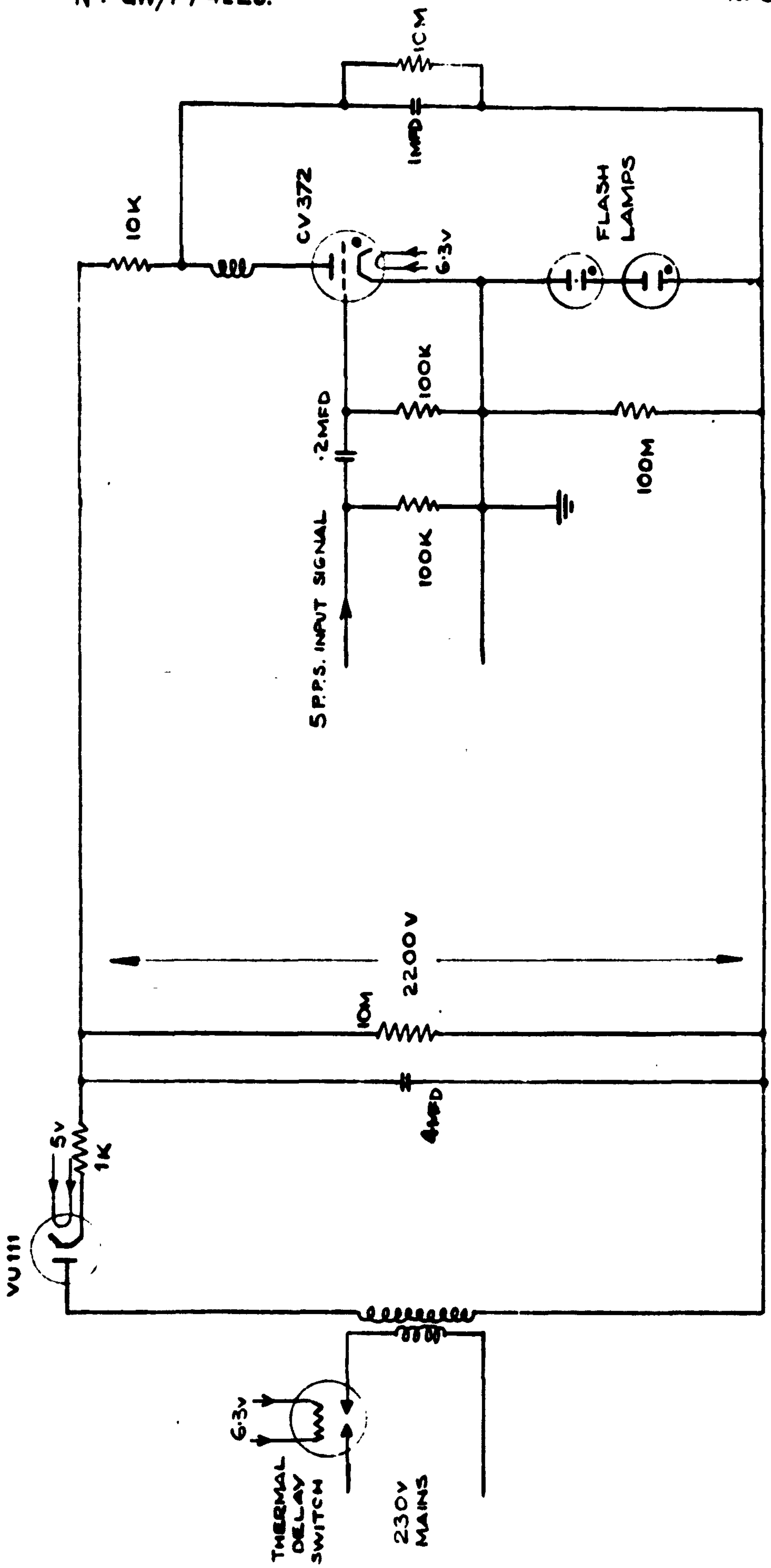


FIG. 5. CIRCUIT DIAGRAM OF FLASH UNIT

No. GW/P/4227.

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FIG. 6.

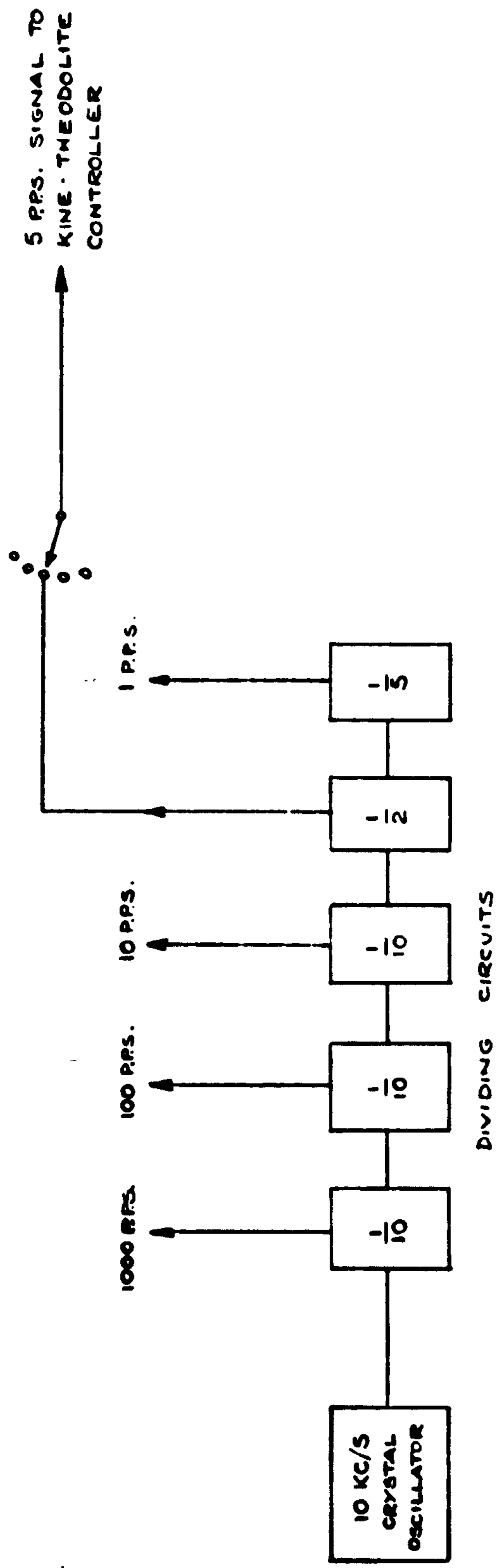


FIG. 6. BLOCK DIAGRAM OF CENTRAL TIMING UNIT

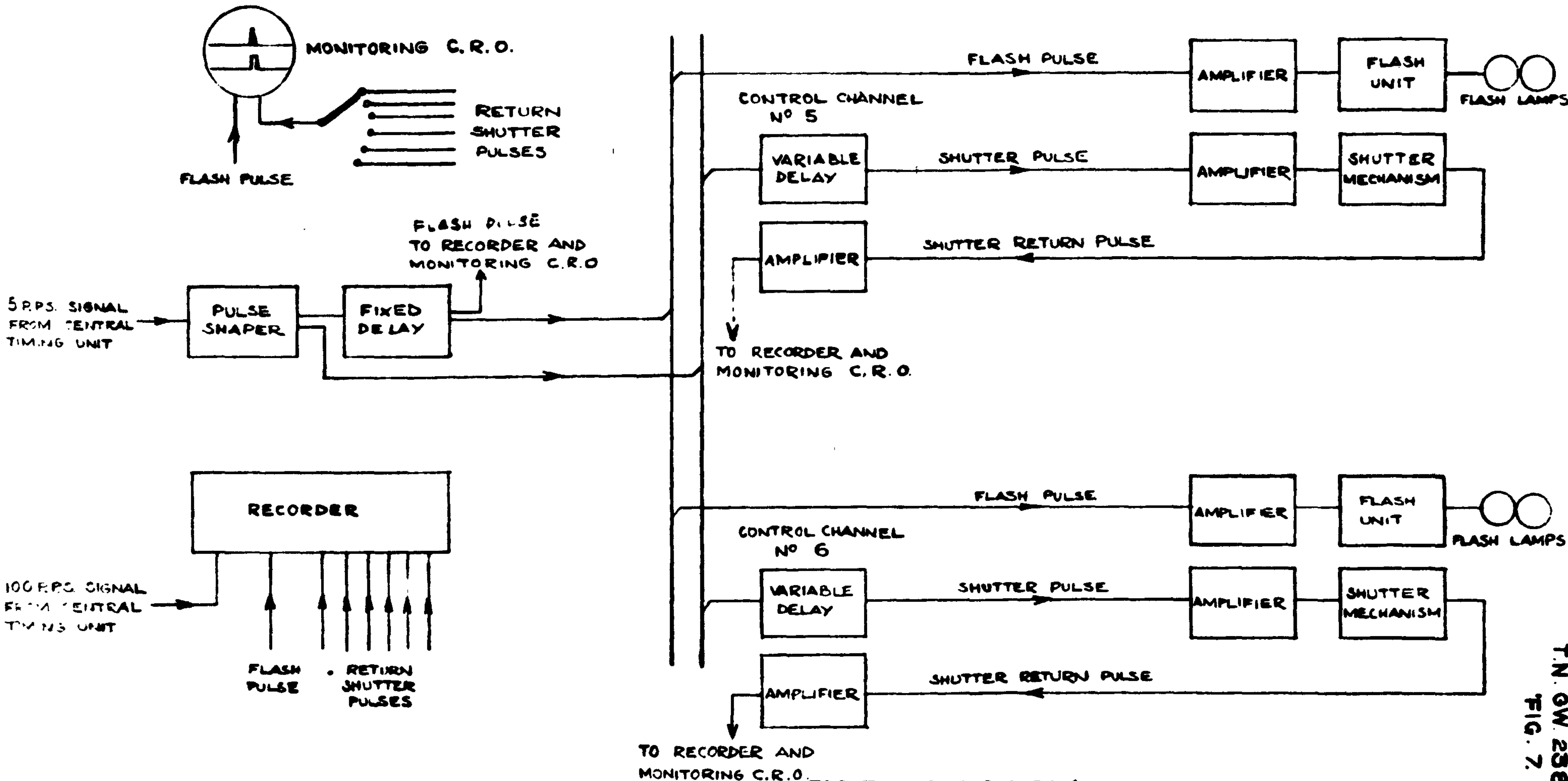


FIG. 7. BLOCK DIAGRAM OF KINETHEODOLITE CONTROL SYSTEM.

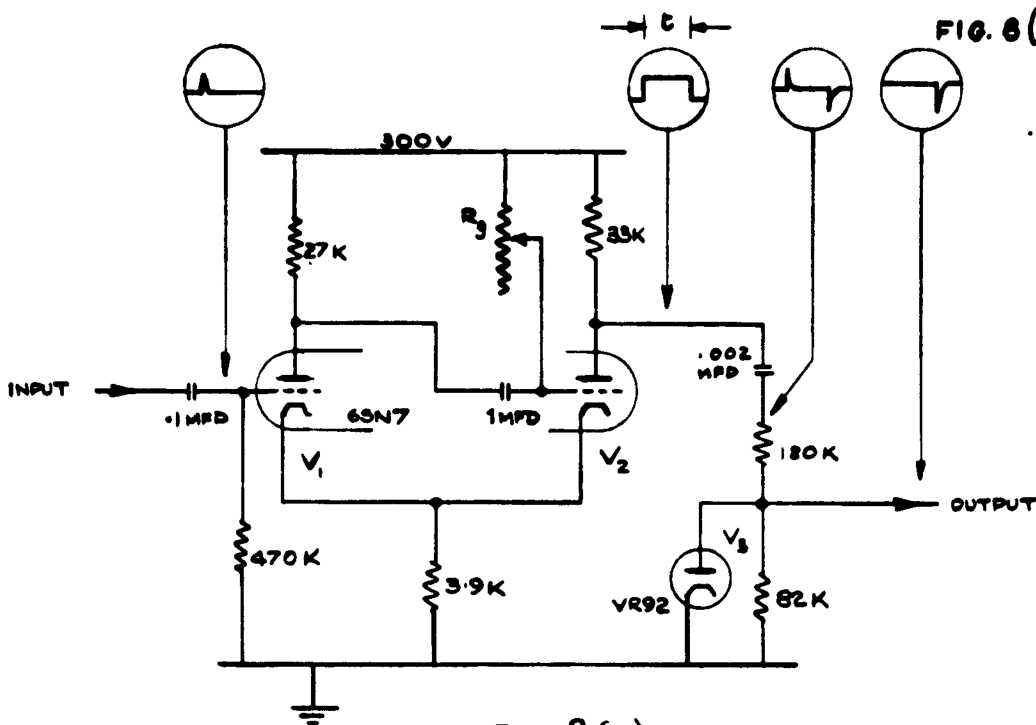


FIG 8(a)

FLIP FLOP DELAY CIRCUIT

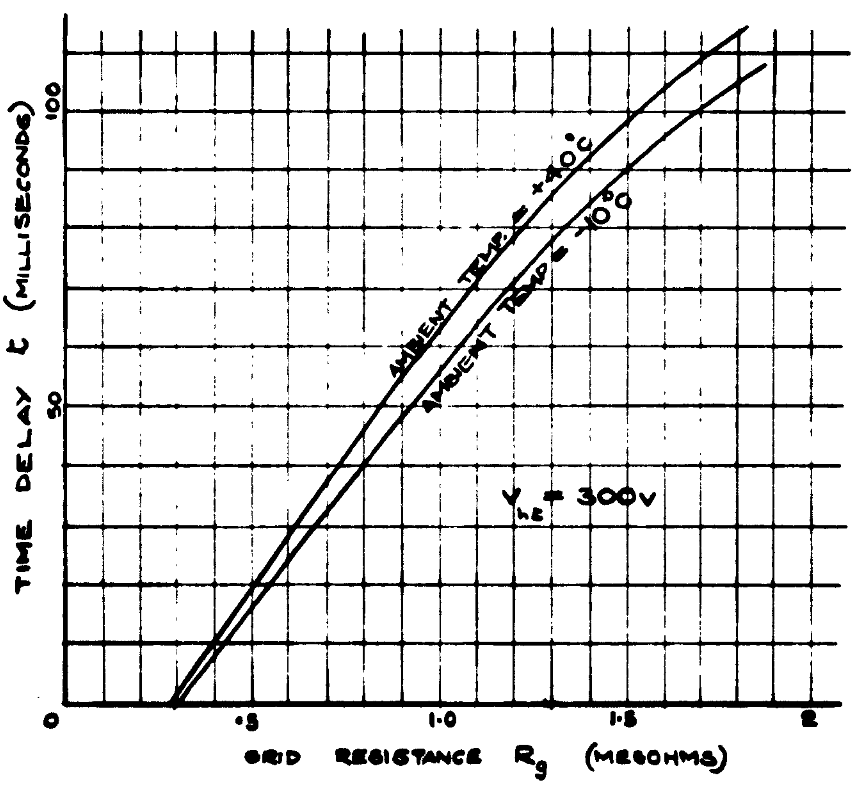


FIG. 8(b). CHARACTERISTICS OF FLIP FLOP DELAY CIRCUIT

No. GW/P/4230.

T.N. GW.238

FIG. 9.

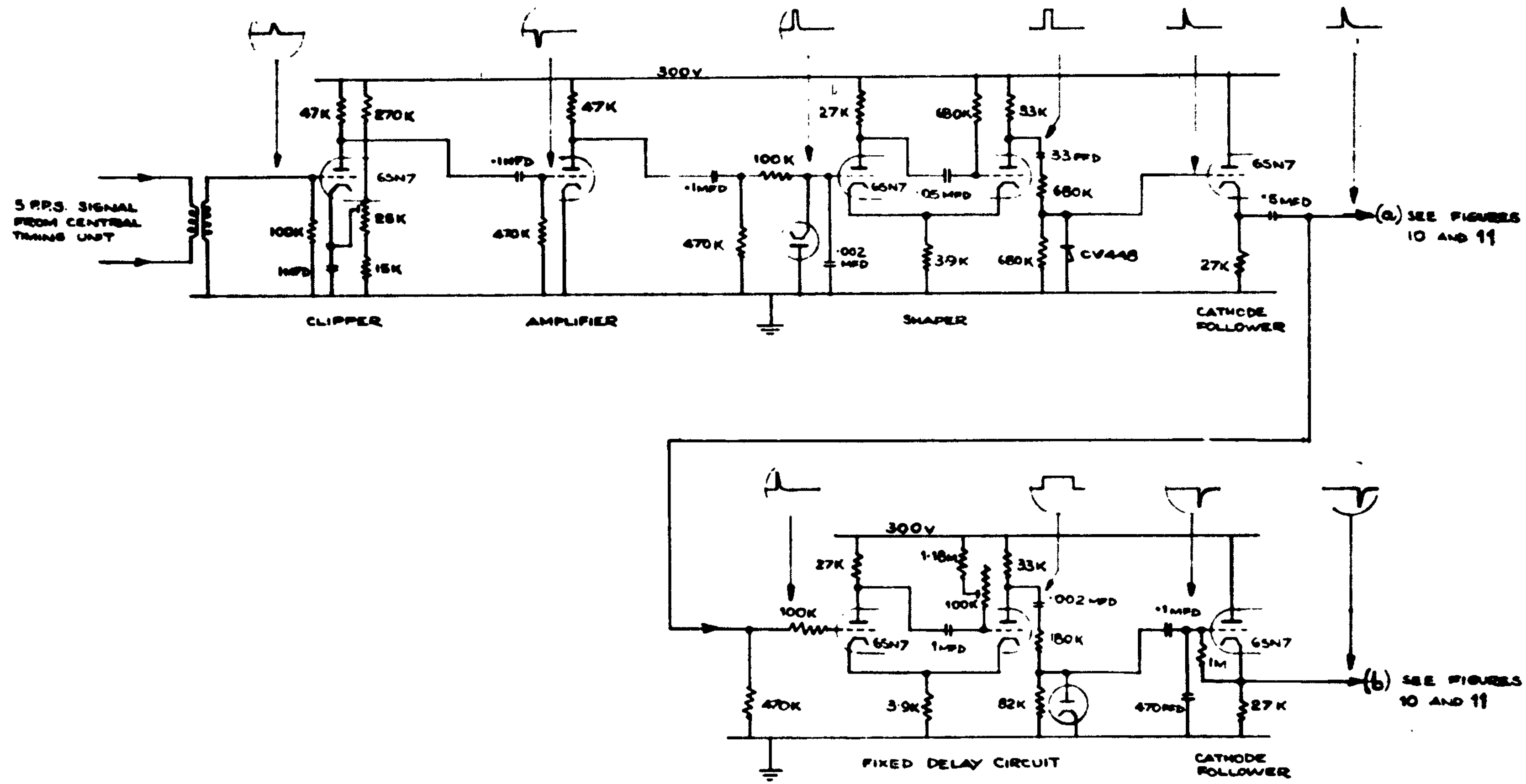


FIG. 9. DIAGRAM OF PULSE SHAPER AND FIXED DELAY CIRCUITS

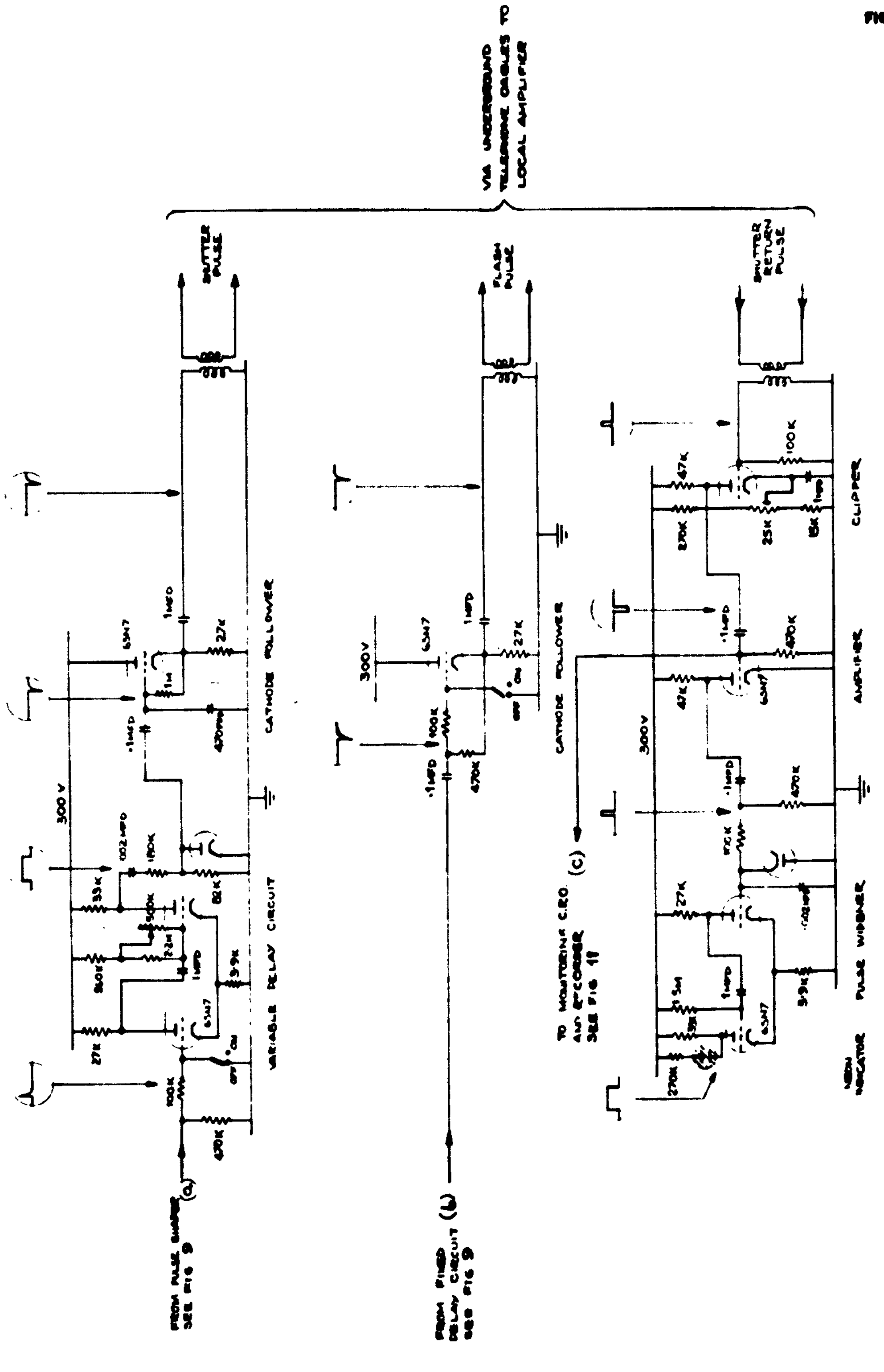


Fig 10

FIG 10. CIRCUIT DIAGRAM OF CONTROL CHANNEL
(6 CHANNELS AS SHOWN)

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FIG 11.

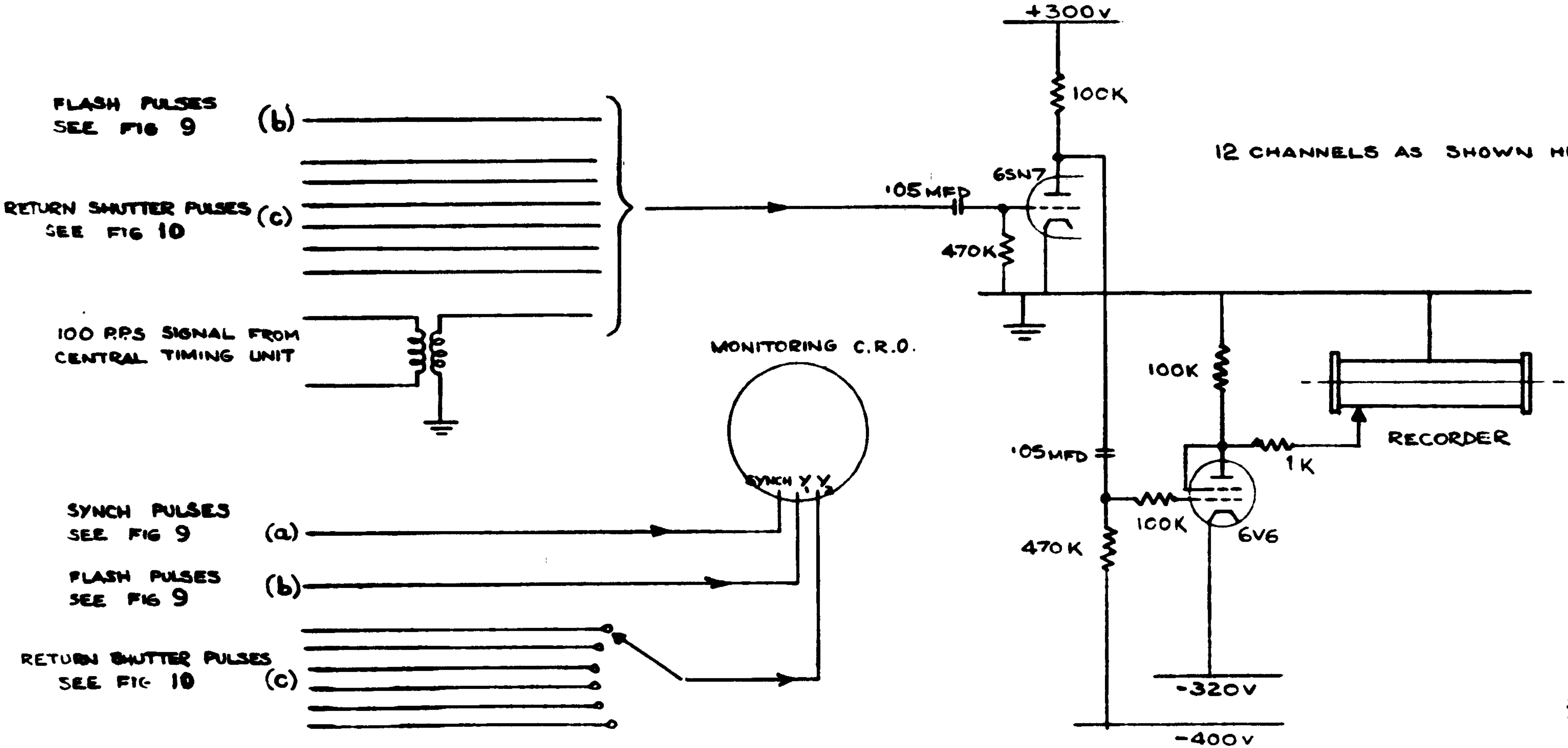



FIG. 11. CIRCUIT DIAGRAM OF RECORDER AMPLIFIER AND MONITORING C.R.O.

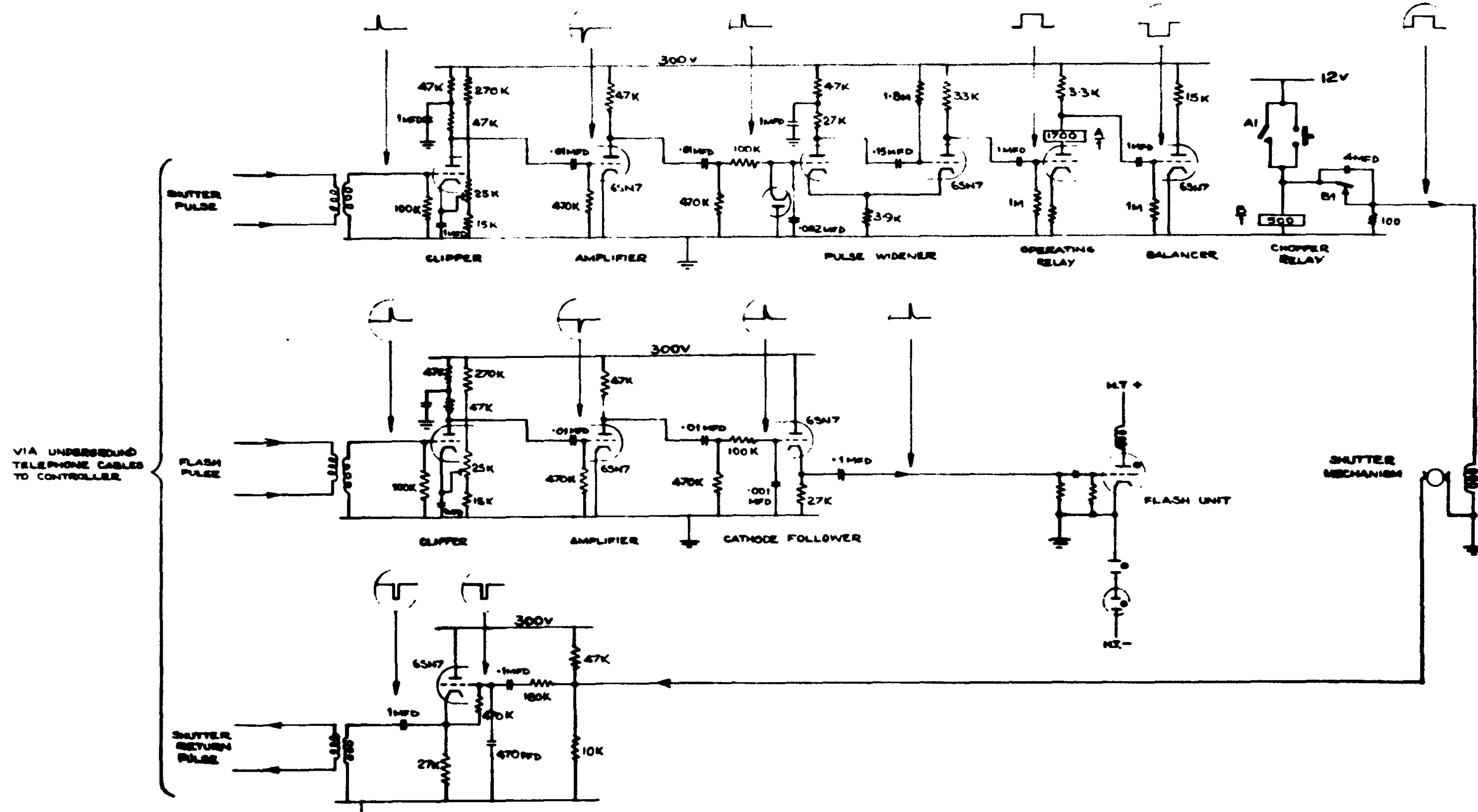



FIG. 12. CIRCUIT DIAGRAM OF LOCAL AMPLIFIER

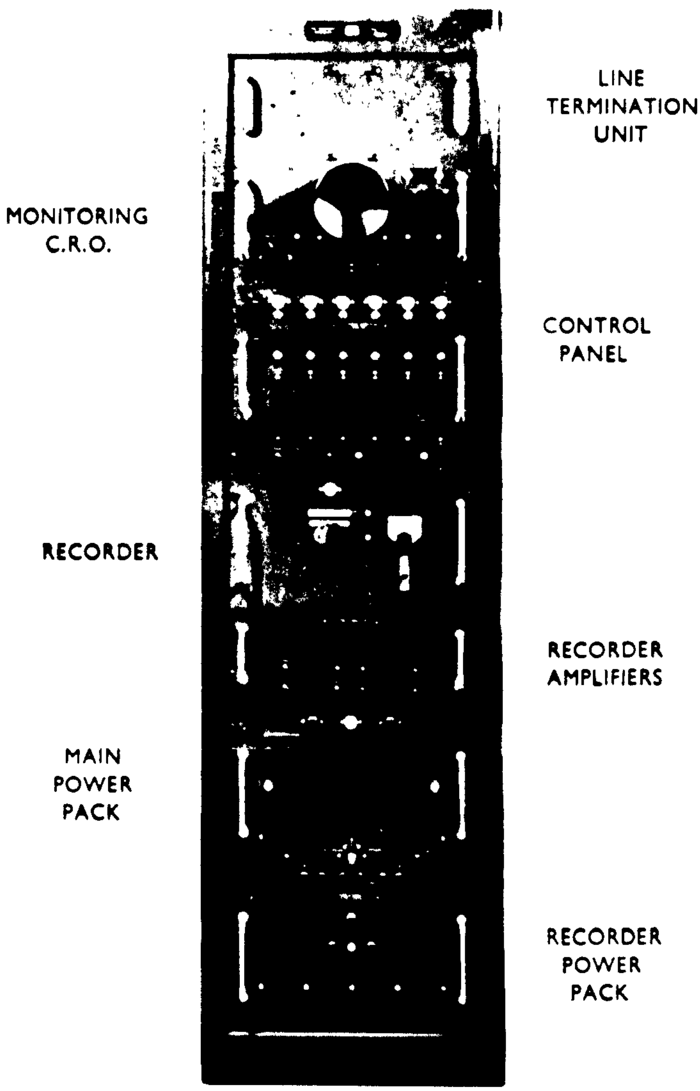
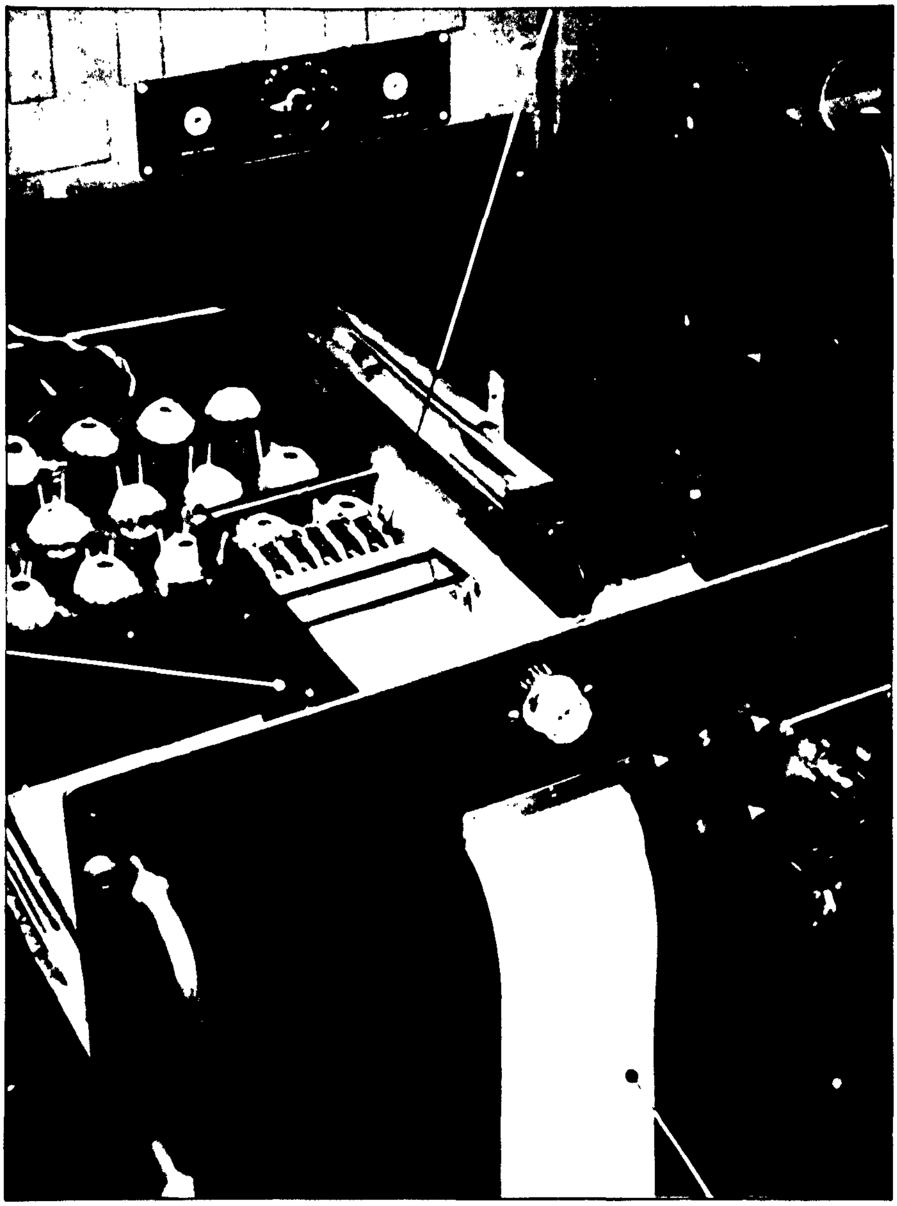



FIG.13. KINE-THEODOLITE CONTROLLER

PEN ASSEMBLY

LOADING SPOOL



RECORDING PAPER

FIG.14. RECORDER

RAE. 104650 53

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The kinetheodolites are used to determine the trajectory and velocity of guided weapons; five or more kinetheodolites being dispersed on the range and controlled from a common point within the launching area.

A Controller operates the kinetheodolite shutters and triggers flash lamps which expose bearing and elevation readings on the kinetheodolite films. The lamps are flashed synchronously to within ±200 microseconds the interval between flashes being 200 milliseconds ±200 microseconds.

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Royal Aircraft Est. Technical Note No. G.W.238 — 526.918.513:
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The report describes a Mk.II version of the equipment which employs electronic delay circuits in place of the relays used in the Mk.I equipment and which is more suitable for operating the remote kinetheodolites over long telephone lines.

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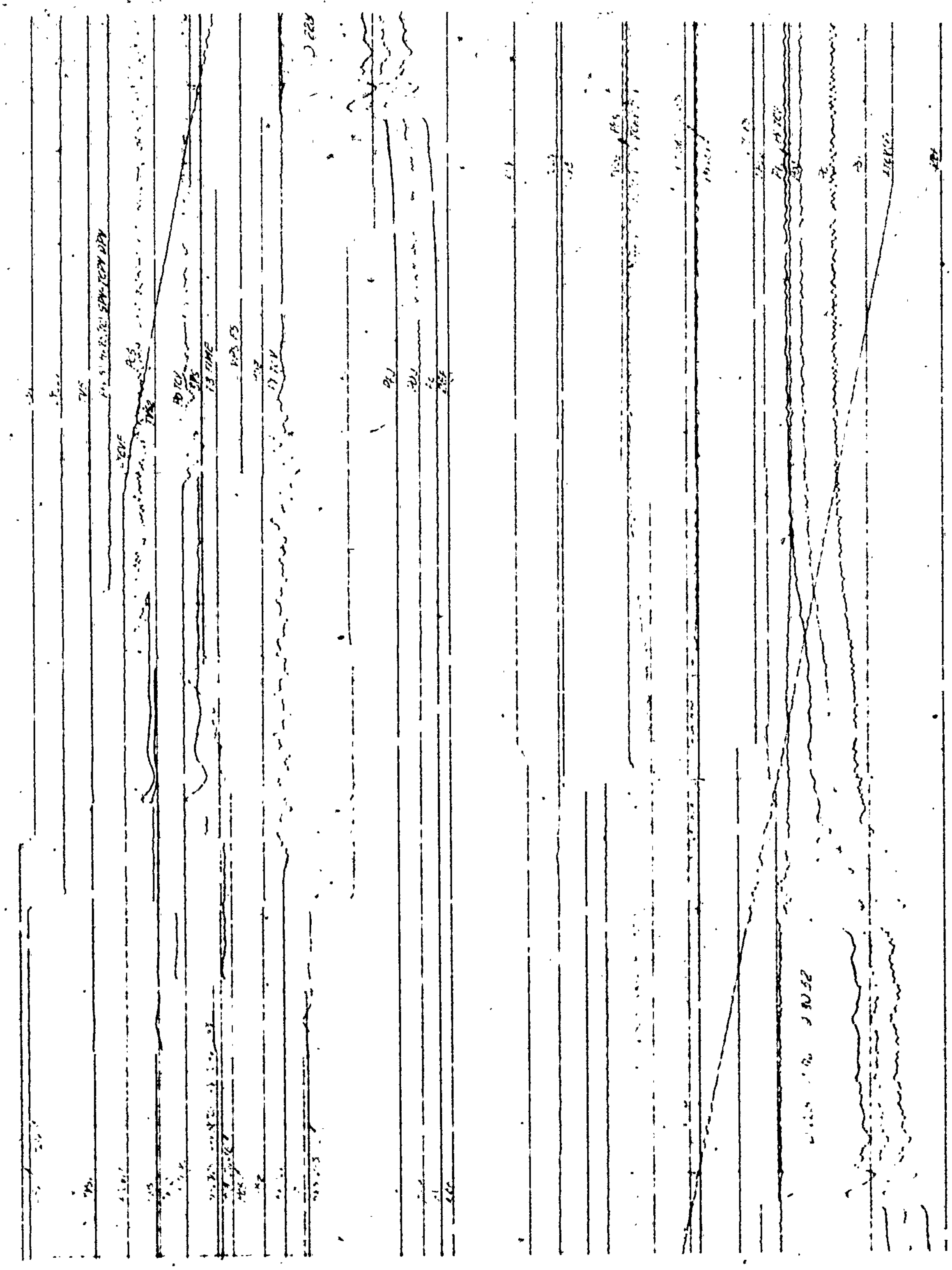

Oscillograph Trace, Test No. D228LM-96

Figure 14
Part III

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